APPENDIX B

ENGINEERING SYMBOLS

Symbol	Units	Term
a	--	factor depending on beach slope Equation [4-5]
	--	parameter used in calculation of confidence limits Equation [3-26]
A	--	storm parameter space
A(t)	ft	amplitude of tide as a function of time
b	--	factor depending on beach slope Equation [4-6]
	--	parameter used in calculation of confidence limits Equation [3-27]
C_d	--	water surface drag coefficient
CPI	in of Hg	central pressure index
C_0 C_1 C_2	--	constants used in approximating the standard normal deviate Equation [3-11]
d	ft	local depth of water
	in of Hg	argument of central pressure deficit D
d_b	ft	depth of water at which significant waves break offshore

Symbol	Units	Term
$\bar{d}_t$	ft	average water depth for two successive reach intervals (used in estimating hurricane waves)
d_1 d_2 d_3	--	constants used in approximating the standard normal deviate Equation. 3-11]
D	ft	total water depth at position x, y and at time t
	in of Hg	atmospheric pressure deficit
D_{max}	ft	maximum depth of water to be expected anywhere in the system (numerical stability consideration)
e	--	2.71828 ....., $e^x = \exp(x)$
erfc(x)	--	complementary error function of x
E	--	event number when events rank from the greatest to smallest magnitude Equations [3-20] and [3-21]
f	rad/sec	Coriolis parameter, $f = 2\omega \sin\phi$
f_f	--	bottom friction factor (used in connection with short period wave dissipation)
F_e	ft	effective wave fetch length

Symbol	Units	Term
F'_e	ft	the effective wave fetch length at the previous computational step as used in the marching procedure for estimating hurricane waves
g	ft/sec	acceleration due to gravity
G	--	skew coefficient
$\bar{G}$	--	skew coefficient when historic and/or outliers are considered
h	ft	seabed elevation relative to datum (usually referenced to NGVD)
H	ft	height of short period surface wave
H	ft	tidal amplitude
H	--	number of years in a historical period Equation [3-14]
H_b	ft	height of short period breaking wave
H_i	ft	height of short period surface wave in particular spatial segment (used in the computation of hurricane waves)
H_o	ft	height of deepwater significant wave
H'_o	ft	equivalent unrefracted deepwater significant wave height

Symbol	Units	Term
HW	ft	high water tidal elevation
k	--	wind stress coefficient (non-dimensional)
	--	surface friction coefficient Equation [C-8]
K	--	bottom stress coefficient (used in conjunction with shallow water waves)
	--	frequency factor
	--	coefficient that is inversely proportional to the square root of the air density just above the water surface Equation [D-2]
K_f	--	short period surface wave decay factor
K_N	--	coefficient depending on sample size Equation [3-13]
K_L	--	frequency factor for lower confidence level Equation [3-25]
K_S	--	shoaling coefficient
K_u	--	frequency factor for upper confidence level Equation [3-24]
l	ft	argument of distance from storm center L

Symbol	Units	Term
L	ft	short period surface wave length
	n mi, mi	distance from storm center
L_o	ft	short period surface wave length in deep water
LW	ft	low water tidal elevation
m	ft/ft	beach slope
		expected mean value Equation [3-32]
$\bar{m}$	--	order of the event when historic data and/or high outliers are included (events arranged in order of magnitude in which the largest event is ranked as 1)
M	--	order of the event (events arranged in the order of magnitude in which the largest event is ranked as 1)
n	--	number of storms Equations [3-32] and [3-33]
N	--	a statistical term denoting the number of events
NGVD	--	National Geodetic Vertical Datum of 1929
p	in of Hg, lb/ft^2	pressure
p_j	--	probability of a storm in a given year Equation [3-33]

Symbol	Units	Term
pdf's	--	probability density functions
p_a	in of Hg	atmospheric pressure
p_n	in of Hg	atmospheric pressure at the outskirts of a storm
p_o	in of Hg	atmospheric pressure in the eye of a hurricane
p_r	in of Hg	atmospheric pressure at a point located at a radial distance r from the storm center
P	--	probability
	ft/sec	precipitation rate (depth/time)
P_N	--	expected probability
P_T	--	exceedence probability of tide
Q	--	reciprocal of m, P(S < s)
r	mi, n mi	radial distance from storm center
	mi, n mi	argument of radius to maximum wind R
R	mi, n mi	radial distance from storm center to region of maximum winds
	ft/sec	rate at which water is gained or lost at the air-sea interface
s	ft	argument of peak surge elevation S

Symbol	Units	Term
S	ft	peak surge elevation
S_b	ft	setdown or decrease in water level from the mean water level at the location where waves break offshore
S_w	ft	wave setup due to waves breaking offshore
t	sec	time
	--	standard normal deviate
	hr	residence time in which the eye of a hurricane is in the Gulf of Mexico
t_m	hr	time of peak surge relative to the time of high tide
T	sec	short period surface wave period
	ft	tide elevation
T_o	sec	deepwater significant wave period
T'_o	sec	equivalent unrefracted deepwater significant wave period
u	ft/sec	x-component water particle velocity
	ft/sec	x-component vertically integrated velocity

Symbol	Units	Term
U	ft^2/sec	x-component of volume transport (per unit width)
v	ft/sec	y-component of water particle velocity
	ft/sec	y-component vertically integrated velocity
	mi/hr, knots	argument of the forward speed of storm V
$\underline{v}$	--	counterpart argument of the storm parameter vector
V	ft^2/sec	y-component of volume transport (per unit width
V	mi/hr, knots	used to denote forward speed of storm
V_f	mi/hr, knots	storm translation speed
V_o	--	conversion factor for selected units Equations [C-5] through [C-7]
V_{gx}	mi/hr	maximum gradient wind speed 10 meters (33 feet) above water surface
V_k	mi/hr, knots	reduced wind speed due to frictional resistance
V_r	mi/hr, knots	wind speed at a point that is located at the radial distance r from the hurricane center

Symbol	Units	Term
V_s	mi/hr, knots	wind speed at a point in a stationary hurricane that is located at a radial distance r from the hurricane center
V_{xm}	mi/hr, knots	maximum sustained windspeed in a moving hurricane
V_{xs}	mi/hr, knots	maximum sustained windspeed in a stationary hurricane
$\underline{V}$	--	storm parameter vector
w	ft/sec	z-component water particle velocity
	--	parameter used in approximating the standard normal deviate Equation [3-12]
W	mi/hr, knots	wind speed 10 meters (33 feet) above the water surface
W	--	weight factor Equation [3-14]
W_m	mi/hr, knots	maximum sustained surface wind speed
W_x , W_y	mi/hr, knots	x and y-components of wind speed 10 meters (33 feet) above surface
x	--	horizontal Cartesian coordinate
	ft	implies statistical event (water level in this manual)

Symbol	Units	Term
x'	ft	magnitude of historic or high outlier annual peak water level
y	--	horizontal Cartesian coordinate
Y	knots(in of Hg)$^{1/2}$	product of the radius of maximum wind and square root of the atmospheric pressure deficit
z	--	vertical Cartesian coordinate
Z	ft	water level at the edge of continental shelf
	--	number of historic peaks including high outliers
Z(t)	ft	elevation of surge as a function of time
α	deg	angle between wave crest at breaking and shore
	--	parameter used in probability density distribution Equation [3-2]
	deg	wind inflow angle in a hurricane (see Figure 1-1a)
β	--	parameter used in probability density distribution Equation [3-2]
	deg	angle between the x-axis and the radial line extending outward from the storm center

Symbol	Units	Term
β	deg	angle between a hurricane track and the maximum wind surface vector
γ	--	parameter used in probability density distribution Equation [3-2]
Γ	--	gamma function
ΔF	ft	incremental distance along wave fetch
Δp	in of Hg	difference in pressure at the periphery of a hurricane and the central pressure within the eye.
ΔS	ft	difference in the water level due to wave setup and the mean water level
Δt	sec	time interval (or time step) between successive calculations
Δx	ft	spatial step in x-direction
Δy	ft	spatial step in y-direction
ϵ_{xx} , ϵ_{xy}	--	eddy viscosity coefficients Equation [1-6]
ϵ_{yx} , ϵ_{yy}	--	eddy viscosity coefficients Equation [1-7]
ζ	ft	astronomical tide potential

Symbol	Units	Term
η	ft	water level elevation relative to the water level
η	ft	annual peak water
η_H	ft	threshold elevation for a high or low outlier Equation [3-13]
η_u , η_L	ft	water level elevations for the upper and lower confidence levels, respectively
κ	--	coefficient depending on the forward speed of a hurricane and the increase in effective fetch due to storm motion
μ	--	sample mean (statistical term)
$\bar{\mu}$	--	sample mean for data that includes either historic data and/or high outliers
Θ	deg	azimuth of the storm track
θ	deg	argument of the azimuth of the storm track Θ
θ	deg	angle between velocity vector and the x-axis (see Equation [1-9]
ξ	ft	atmospheric pressure deficit
π	--	3.14159.....
ρ	lb-sec^2/ft^4	water density

Symbol	Units	Term
ρ_a	lb-sec²/ft⁴	air density
σ	--	standard deviation
$\bar{\sigma}$	--	standard deviation when either historic data and/or high outliers are included
Σ	--	denotes a summation
τ	hr	time to first positive peak of the fore runner surge after entry of hurricane eye into Gulf of Mexico
τ_{bx} , τ_{by}	lb/ft²	x and y-components of bottom stress
τ_{sx} , τ_{sy}	lb/ft²	x and y-components of surface stress
τ_{xx} , τ_{xy} , τ_{xz}	lb/ft²	turbulent shear stresses Equation [1-1]
τ_{yy} , τ_{xy} , τ_{yz}	lb/ft²	turbulent shear stresses Equation [1-2]
ϕ	deg	earth's latitude
ω	rad/sec	angular velocity of earth ($\omega = 2\pi/24$ rad/hr)
	rad/sec	tidal frequency (2π/period)
∞	--	signifies infinity